

Claims.

1. An optical circuit for an optical amplifier input stage comprising a first optical waveguide for carrying a signal beam to be amplified, a second optical waveguide for carrying a pump beam, a beam combining means optically coupled to the first and second optical waveguides for producing a combined signal/pump beam, and means for optically coupling the combined signal/pump beam into an amplifying optical waveguide, characterised in that the first and second optical waveguides are hollow core optical waveguides formed as channels in a substrate.
2. An optical circuit according to claim 1 wherein the beam combining means is formed monolithically from the substrate.
3. An optical circuit according to claim 1 wherein the beam combining means is a discrete component held in an alignment slot formed in the substrate.
4. An optical circuit according to any preceding claim and further comprising a laser source arranged to couple a pump beam into the second hollow core optical waveguide.
5. An optical circuit according to any preceding claim wherein first optical fibre attachment means are provided to receive an input optical fibre, the first optical fibre attachment means being arranged such that any signal beam carried by an attached input optical fibre is coupled into the first hollow core optical waveguide.
6. An optical circuit according to any preceding claim wherein at least one optical isolator is located within the optical path defined by the first hollow core optical waveguide.
7. An optical circuit according to any preceding claim wherein at least one variable optical attenuator is located within the optical path defined by the first hollow core optical waveguide.

8. An optical circuit according to any preceding claim wherein the amplifying optical waveguide comprises an amplifying material formed as an elongate waveguide in or on the substrate.
9. An optical circuit according to any preceding claim wherein the amplifying optical waveguide comprises an amplifying optical fibre.
10. An optical circuit according to claim 9 wherein the means for coupling the combined signal/pump beam produced by the beam combining means into an amplifying optical fibre comprises a third hollow core optical waveguide formed as a channel in the substrate, the third hollow core optical waveguide being arranged to receive the combined signal/pump beam from the combining means.
11. An optical circuit according to claim 10 wherein second optical fibre attachment means are provided to receive an amplifying optical fibre, the second optical fibre attachment means being arranged to couple the combined signal/pump beam from the third hollow core optical waveguide into an attached amplifying optical fibre.
12. An optical circuit according to any preceding claim and further comprising at least one optical tap to extract light from the first hollow core optical waveguide.
13. An optical circuit according to claim 12 and further comprising a first photodiode, wherein light extracted from the first hollow core optical waveguide is directed to the first photodiode.
14. An optical circuit for an optical amplifier output stage comprising a first output optical waveguide arranged to receive light from an amplifying optical waveguide and an optical fibre attachment means arranged to receive an output optical fibre wherein light from the amplifying optical waveguide is optically coupled to the output optical fibre via the first output optical waveguide, characterised in that the first output optical waveguide is a hollow core optical waveguide formed as a channel in a substrate.

15. An optical circuit according to claim 14 wherein the amplifying optical waveguide comprises an amplifying optical fibre and the optical circuit comprises a further optical fibre attachment arranged to receive the amplifying optical fibre.
16. An optical circuit according to claim 14 wherein the amplifying optical waveguide comprises an amplifying material formed as an elongate waveguide in or on the substrate.
17. An optical circuit according to claim 14 wherein a second output hollow core optical waveguide for carrying a pump beam is formed as a channel in the substrate and means are provided to optically couple the pump beam from the second output hollow core optical waveguide into an amplifying waveguide via the first output hollow core optical waveguide.
18. An optical circuit according to claim 17 and further comprising a laser source arranged to couple a pump beam into the second output hollow core optical waveguide.
19. An optical circuit according to any one of claims 14 to 18 wherein at least one optical isolator is provided within the optical path defined by the first output hollow core optical waveguide.
20. An optical circuit according to any one of claims 14 to 19 wherein at least one optical tap is provided within the optical path defined by the first output hollow core optical waveguide.
21. An optical circuit according to any one of claims 14 to 20 wherein at least one optical filter is provided within the optical path defined by the first output hollow core optical waveguide.

22. An optical circuit for an optical amplifier comprising an optical circuit for an amplifier input stage according to any one of claims 1-13 and an optical circuit for an amplifier output stage according to any one of claims 14-21.
23. An optical circuit according to claim 22 wherein the optical circuits for the input and output stages are formed on a single substrate.
24. An optical circuit according to any preceding claim wherein the substrate comprises semiconductor material.
25. An optical circuit according to claim 24 wherein the substrate comprises a silicon on insulator (SOI) wafer.
26. An optical circuit according to any preceding claim formed by micro-fabrication techniques.
27. An optical circuit according to claim 26 wherein the micro-fabrication technique includes deep reactive ion etching.
28. An optical circuit according to any preceding claim wherein the hollow core optical waveguides are of substantially rectangular cross section.
29. An apparatus according to any preceding claim wherein the hollow core optical waveguides are dimensioned to preferably guide radiation propagating in the fundamental mode.
30. An apparatus according to any one of claims 1 to 28 wherein the hollow core optical waveguides are dimensioned to preferably guide radiation propagating in multiple optical modes.
31. An optical circuit according to any preceding claim wherein the internal surfaces of the hollow core optical waveguides carry a reflective coating.

32. An optical circuit according to any preceding claim wherein the substrate comprises a base portion and a lid portion.
33. An optical amplifier comprising an optical circuit according to any preceding claim.
34. An optical amplifier according to claim 33 and further comprising an erbium doped optical fibre.